DISPERSION OF A POPULATION OF BI-DISPERSE INERTIAL PARTICLES IN A TURBULENT FLOW

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Abstract We report measurements of the evolution of a population of bi-disperse particles from a numerical study of turbulent flow at Taylor Reynolds number 433. Our measurement is based on the Johns Hopkins direct numerical simulation of forced isotropic turbulence on a $1024 \times 1024 \times 1024$ periodic grid [1, 2]. The inertial particles are point particles characterized by two distinct Stokes numbers, 0.1 and 0.5, and they are advected by the flow with one-way coupling incorporating a Stokes law to account for the drag force. The bi-disperse particles are aligned on a regular $5 \times 5 \times 5$ grid, with alternating Stokes numbers between adjacent neighbors. We explore the spreading rate of the particles with initial separation varying from the dissipative to the inertial length scales. For time scales less than or on the order of the Kolmogorov time scale, ballistic motion is observed for both cases of initial separations. We found the evolution of the mean square separation can be described by a Batchelor-like scaling law with the bimodal Stokes numbers affecting only the velocity structure function occurring in the mean square separation.

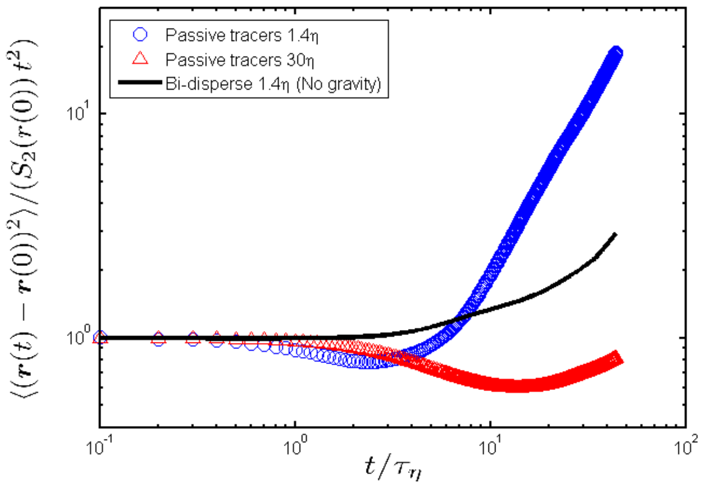

Figure 1. Relative dispersion, $\langle(\boldsymbol{r}(t) - \boldsymbol{r}(0))^2\rangle$, of passive tracers compensated by a Batchelor-like scaling for initial separations: $r(0) = 1.4\eta$ ($\bigcirc$) and 30η ($\triangle$), and of bi-disperse inertial particles for initial separation $r(0) = 1.4\eta$ under no gravity condition (solid line). $S_2(r(0))$ is the Eulerian second order structure function for a given initial separation $r(0)$. The Kolmogorov time scale, τ_η, of this flow is 0.0446, and the corresponding Kolmogorov length scale, η, is 0.00287.

References

[1] Y. Li, E. Perlman, M. Wan, Y. Yang, R. Burns, C. Meneveau, R. Burns, S. Chen, A. Szalay, and G. Eyink. A public turbulence database cluster and applications to study Lagrangian evolution of velocity increments in turbulence. *Journal of Turbulence* **9**, No. 31, 2008.

[2] E. Perlman, R. Burns, Y. Li, and C. Meneveau. Data Exploration of Turbulence Simulations using a Database Cluster. *Supercomputing SC07*, ACM, IEEE, 2007.